REMARKS

Amendments to the Specification: Paragraphs [0004], [0006], [0007], [0011], [0014], [0029], [0030], [0032], [0034], [0036], [0037], and [0038] have been amended to correct minor typographical errors. Paragraph [0028] has been amended to add the patent number for the case that was referenced and has now issued. Additionally, paragraph [0037] has been amended to better describe the calculations illustrated in Figs. 7-9. Support for the amendment can be found in Figs. 7-9. Additionally, a new paragraph has been added in the specification after paragraph [0030] to provide a written description of Fig. 1A. The support for this amendment can be found in Fig. 1A itself, as well as in paragraph [0019].

Amendments to the Claims: Claims 6 and 7 have been amended to recite boron-containing glass. Support for this amendment can be found in paragraph [0007]. New claims 21 – 60 have been added. Support for Claims 21-30 can be found in the specification in paragraph [0014] and in the Figures. Support for Claims 31-40 can be found in Paragraph [0030]. Support for Claims 41-50 can be found in paragraph [0030]. Support for claims 51-60 can be found in paragraphs [0030] and [0036]-[0038] and Figs. 7-9.

The Examiner has rejected Claims 1-10 and objected to Claims 11-20 in the present office action.

Rejection under 35 USC 102(b)

The examiner has rejected Claims 1, 2, and 5-8 under 35 USC 102(b) as being anticipated by Hossain et al (US Patent 6,075,261). The examiner states, that regarding Claim 1, "Hossain discloses a neutron detection device (Fig. 1a-1e) comprising an active semiconductor layer 121 located in close proximity to said cells. Regarding Claim 2, Hossain discloses an insulating layer including a plurality of charge-sensitive cells 103: and a neutron conversion layer 121 located in close proximity to said cells. Regarding Claims 5 and 8, Hossain discloses that suitable neutron-reactive elements include Boron and Lithium (Col. 3, line 2). Regarding Claim 6, Hossain discloses that the conversion layer comprises borophosphosilicate glass. Regarding Claim 7, Hossain

discloses that the concentrations of boron in borophosphosilicate glass fall in the range of 80-100 percent.

To be anticipating, a reference must disclose every element of the claim. *Scripps Clinic & Res. Found. v. Genentech, Inc.*, 927 F.2d 1565, 1676 (Fed. Cir. 1991); *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989); M.P.E.P. § 2131. If the reference omits any element of a claim, then there is no anticipation. See *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 1571 (Fed. Cir. 1986).

As discussed extensively in the attached Declaration of Robert R. Whitlock, while Hossain claims "a neutron reactant material *near* the memory cells" (claim 1), Hossain does not teach or disclose "near" in a functionally adequate manner. as is disclosed by the "close proximity" of the present Claim 1.

Hossain does not fully disclose the meaning of *near* as being within a physically definable range computed from a consideration of the attenuating effect of all material in the path of the nuclear product (e.g., alpha) particle as it transits from its point of origin, i.e. the site of the nuclear reaction. to the charge-sensitive region of the detector circuit (memory cell), together with a consideration of the remaining energy deposited by the particle in the memory cell (provided the particle reaches that destination), and further in consideration of the energy deposit required for detection.

Hossain provides scant guidance on neutron-reactant layer thicknesses. "The thickness of the neutron-reactant material is selected to allow penetration of some of the emitted particles, such as 4-alpha, into the underlying memory cell. Suitable thickness range from about 2000 to 5000 angstroms for many applications." (Column 3, line 50). Hossain does not provide any method for determining optimal thickness for the neutron-reactant material. In actuality. this varies drastically with composition and isotope. The thickness numbers provided by Hossain would be sub-optimal for solid boron-10 by a factor of about 5 to 12, either factor being a critical variation. Hossain's determination of thickness apparently only considers escape distance for the product particle

(alpha). He does not include penetration depth of the reactant (neutron). In practical application, optimal thickness must take both into account. Hossain's teaching on thickness of neutron-reactant layers is incomplete, does not account for neutron penetration ranges, and does not adequately account for nuclear product (e.g., alpha) penetration ranges.

Hossain provides the following scant guidance on insulating layer thicknesses. Hossain discloses an insulating layer 119 with reference to Figure 1A. Although he does not include the indicium 119 on the figure, the description (Column 2, line 61) makes clear that the insulating layer 119 is above and around the gate structure 109. More particularly Hossain incompletely and inadequately discloses the insulating layer, "Formed over the gate structure 109 may, for example, be an insulating layer 119, such as an oxide" (Col. 2, Line 59). The thickness of the insulating layer 119 is not disclosed, and is not identified as an important parameter. Assuming that the thickness of the insulating layer 119 is of on the scale of thicknesses typical of components in microcircuits, these thicknesses may be appreciable when compared to the range of the nuclear product particles, such as the alpha particle produced upon capture of a neutron; the efficiency and even the useful operation of the device as a neutron detector can be compromised by an inappropriate choice of thickness, even for thickness in the range of typical components of microcircuits. The passivation layer for this purpose may be considered a typical component of a microcircuit. "The passivation layer 129 is typically an oxide, such as silicon dioxide" Column 4, line 1 and is an insulator. Assuming the thickness of the insulating layer 119 may be equivalent to the disclosed thickness of Hossain's passivation layer (col. 4, line 3). "from about 500 to 5000 angstroms and up". Hossain's specified thickness has no upper limit, and passivation layers may be hundreds of microns thick, much thicker than the range of a nuclear product (e.g., alpha) particle. Even at 5000 angstrom thickness, reductions in efficiency occur. Range of nuclear products (e.g., alpha) is not discussed. Hossain's teaching of insulator thickness, as inferred from passivation layer thickness, is incomplete and does not account for nuclear product (e.g., alphas) ranges. Thus, Hossain does not define or teach proximity in the matter of the insulating layer 119.

Hossain states that the insulating layer 119 "may" be formed. In the allowed case that the insulating layer 119 is not formed, then Hossain has not disclosed that a thereafter applied neutron-

reactant material, which is chemically or electrically active (such as lithium metal) or electrically conductive, will impact the functioning of the memory cell and associated circuitry, and could render these non-functional. Also in the allowed case that the insulating layer 119 is not formed, then Hossain has not disclosed that the penetration of nuclear product (e.g., alpha) particles through material, such as the gate structure and conductors, may be insufficient for the nuclear product (e.g., alpha) particles to reach the memory cells with sufficient remaining energy to change the state of a memory cell.

Hossain provides scant guidance on the thickness of circuit structure layers. Hossain discloses a layered gate structure 109 with several components (Figure 1A), but does not disclose the thicknesses of the components, or their individual or combined effect on nuclear product (e.g., alpha) penetration. Hossain does not disclose the thickness of other components intervening between his neutron-reactant material and his memory cell, nor does he teach the undesirable attenuation by which those intervening components prevent nuclear product (e.g., alpha) particles from reaching the memory cells with sufficient energy remaining to be detectable, nor does he teach that sufficient thickness of the intervening components can render the device ineffective, inefficient or useless as a neutron detector. Thus, Hossain does not define or teach proximity in relation to intervening circuit layers or material or components.

Hossain discloses only the thickness of his *neutron-reactant layer* as being important for penetration of the emitted nuclear product (e.g.. alpha) particles (Col. 3, Line 50). His teaching, then, is that only this *thickness* is to be considered in regard to penetration of the nuclear product (e.g., alpha) particles. Hossain omits any teaching of the vital importance of other intervening materials in preventing nuclear product (e.g., alpha) particles from reaching the memory cells. The thickness of the neutron-reactant layer does not define or teach the *proximity* of the neutron-reactant layer to the memory cells. In short, Hossain teaches only the vaguest notion of how *near* the neutron-reactant material may be to the charge-sensitive region, and does not disclose *how near it must be.* This proximity or "near" is left undefined.

As a nuclear product (e.g., alpha) particle penetrates through material intervening between the neutron-reactant and the memory cell, it loses energy through attenuation as it goes. If the intervening material is sufficiently thick, the particle will not reach the memory cell. Even if the particle reaches the memory cell after passing through intervening material, the remaining energy deposited by the particle in a memory cell may be insufficient to change the state of the memory cell. Hossain has not taught the design principles whereby these undesirable outcomes may be prevented. Without this teaching the operation of a functional detector built from his instruction cannot be assured.

Hossain indicates that "other types of memory cells such as dynamic random access memory (DRAM) cells, static random access memory (SRAM) cells, or charge coupled devices (CCD) may be used with the present invention," Col. 4. Line 14. However, the structure of some of these circuits is so complicated, involving so many structural layers, that the range of an alpha particle produced on the top of the layer is much smaller than the thickness of the circuit structure, and the alpha will never reach the memory cell below. Hossain's placement of neutron-reactant layer will be ineffective in making a functioning neutron detector in such cases. Hossain does not disclose teaching to recognize or avoid this situation. Hossain's meaning of "near" (claim 1) is insufficiently disclosed.

The examiner stated that Hossain discloses "10-Boron may range from about 80 to 100 percent of the total Boron concentration." The natural abundance of 10-Boron is about 20% of boron atoms. Isotopically enriched boron may be used to prepare BPSG to achieve the concentrations stated by Hossain. However, Hossain does not take note of the overall concentration of boron in BPSG. According to a scientific review article, "The boron and phosphorous contents of the silicate glasses vary depending on the application, typically being from 2 to 8 wt.%." ("CVD of SiO_2 and Related Materials: an Overview," Andrew R. Barron, ADVANCED MATERIALS FOR OPTICS AND ELECTRONICS, VOL 6, 101 - 114 (1996).) The concentration of Boron is therefore no more than 8 weight percent at best, even in a sample made of isotopically pure 10-Boron with no 11-Boron. Thus, the great majority of material in BPSG is merely another intervening attenuating material that depletes the energy of the nuclear product (e.g., alpha) particles, as mentioned above.

Hossain does not teach the energy loss or attenuation of nuclear product (e.g., alpha) particles in the phosphorous, silicon, and oxygen (PSG) of the BPSG, and does not teach how the presence of this attenuation places further requirements that any additional attenuation from other intervening materials be small. Hossain does not teach or disclose the tightened requirement for close proximity due to attenuation in the PSG.

Therefore, Hossain does not have a method to gauge proximity of the neutron-reactant material to the memory cells. He certainly does not teach or disclose close proximity, as is claimed in the present invention.

Applicants respectfully submit that the forgoing arguments have overcome the Examiner's rejection and respectfully request reconsideration.

Rejection Under 35 USC §103

The examiner has rejected Claims 3 & 4 under 35 USC §103(a) as being unpatentable over Hossaim in view of Brandl et al (US Pub. 2005/0067695). The examiner states that Hossain "discloses the invention according to claim 1, but does not expressly disclose a barrier layer located between the neutron conversion layer and the active semiconductor layer. Brandl discloses that a barrier layer is formed between the integrated circuit and the metal layer (between the neutron conversion layer and the active semiconductor layer) which prevents diffusion of atoms from the metal layer into the integrated circuit. Brandl also discloses that the barrier layer may be made of silicon nitride, which limits dispersion of atoms of the metal layer into the sensor element".

The applicants respectfully disagree. To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and

the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

The applicant respectfully submits that the examiner has not presented a prima facie case of obviousness. There is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify Hossain in view of Brandl. The diffusion of Brandl is different than the diffusion of the present invention. In contrast to Brandl-like diffusion during processing, in the present invention a more stringent requirement applies in that diffusion must be prevented from taking place *after fabrication and during years of use*. This factor is of importance in the present case, but entirely irrelevant in the case of Brandl.

Brandl teaches a diffusion barrier layer [0019] in the case of eutectic formation under conditions of intentionally elevated temperature and pressure [0013], in which a liquid is first formed [0051] of the interdiffusing semiconductor and the metal, which finally hardens into a uniform eutectic structure. Examiner refers to [0019] in regard to preventing of "diffusion of atoms from the metal layer (lithium) into the integrated circuit (semiconductor layer)".

The diffusion that is being hindered by Brandl's barrier is that taking place during processing, i.e., during the formation of the eutectic bond. It is obvious that a barrier layer would be needed under Brandl's processing conditions. However, it is not obvious from Brandl that the processing conditions in the present invention require similar processing treatment. The conditions of elevated pressure do not apply. The conditions of elevated temperature do not necessarily apply, and can be avoided in certain of the available processing approaches. Achieving a liquid state in semiconductor material is not at all in view in the present invention, and is not required of any non-semiconductor material, and can be avoided in certain of the available processing approaches.

The requirements for diffusion barrier effectiveness also differs from Brandl. Brandl is concerned with the controlled use of diffusion to produce mechanical bonding by the eutectic, and in some cases, additionally with electrical conductivity through the eutectic, where the concentration of diffused atoms is sufficient to alter composition, e.g. to transition from pure

substances to a 6:94 compositional ratio [0049]. In the present invention, diffusion of the neutron conversion is discussed in terms of preventing diffusion down to the very small doping levels at which the electrical properties of semiconductor circuitry may be altered. It is not obvious from Brandl that a diffusion barrier sufficient for his purposes would at all suffice for the more stringent requirements of the present invention. It is certainly not obvious from Brandl that a diffusion layer is even needed in the present invention.

Additionally, while Brandl works with semiconductor detectors, he does not teach neutron semiconductor detectors. His use of diffusion barriers is with semiconductor materials, but he is not using the barrier to prevent diffusion into the active semiconductor detector element. He is using the barrier to limit the diffusion into a micromechanical structural element that happens to be made of semiconductor material. While his eutectic bonding does allow for gross electrical conductivity of nearby conductive leads. his eutectic bonds are well removed from any semiconductor transistors or semiconducting circuit elements. This is different from the present invention, where diffusion barriers prevent diffusion into the active semiconductor circuit elements. Thus one skilled in the art would not be motivated to combine the diffusion layer of Brandl, one that has a different purpose and a different effectiveness requirement, with the invention of Hossain, to arrive at the present invention.

Additionally, to establish a prima facie case of obviousness, there must be a reasonable expectation of success. As discussed above with respect to Hossain, the proximity of the neutron reactant layer to the active semiconductor layer in Hossain is disclosed to be too large to be effective. Adding another layer between the neutron reactant layer and the memory cells of Hossain would further decrease any possibility of producing an effective neutron detecting device.

Additionally, to establish a prima facie case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. As discussed above. Hossain does not teach or disclose every element of the present invention, and Brandl does not supply what Hossain is missing. In the present invention, diffusion of the neutron conversion layer is discussed in terms of preventing diffusion down to the very small doping levels at which the

electrical properties of semiconductor circuitry may be altered. The diffusion barrier of Brandl would not necessarily meet the more stringent requirements of the present invention.

Thus, applicants respectfully submit that the examiner's rejection has been overcome and request reconsideration.

Rejection Under 35 USC §103

The examiner has rejected Claims 9 & 10 under 35 USC §103(a) as being unpatentable over Hossain in view of Kurkoski et al (US Pub. 20040178337 A1). The examiner states that Hossain "discloses the invention according to claim 1, but does not expressly disclose a neutron detection device further comprising a second neutron conversion layer. Kurkoski discloses that a neutron detector conversion layer is preferably manufactured to comprise multiple layers to provide good capture as neutrons strike the planar sensing surface [0057].

Applicants submit the attached Declaration pursuant to 37 C.F.R. 1.131. The purpose of the Declaration is to swear behind the Kurkoski reference. Establishing a date prior to the effective date of this reference obviates the examiner's rejections. As the Declaration establishes, the inventors were in possession of the invention prior to the March 11, 2003 date of the reference.

Attached with the Declaration are photocopied pages of the invention disclosure as submitted by the co-inventors. The present invention was made before the effective filing date of the Kurkoski reference. Enclosed is the Declaration of co-inventor Robert R. Whitlock attesting to the date of the disclosure.

Allowance/Objection to Claims 11-20.

Under the heading "Allowable Subject Matter", the examiner stated that Claims 11-20 were objected to as being dependent upon a rejected base claim but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The examiner then provides a statement of reasons for the indication of allowable subject matter.

Applicants believe the office action contains a minor error and the examiner intended to state that Claims 11-20 were allowable as written. Claims 11 and 16 are independent claims. Claims 12-15 depend, either directly or indirectly from Claim 11. Claims 17-20 depend, either directly or indirectly from Claim 16. Applicants request clarification of the status of these apparently allowed claims. Applicants thank the examiner for the indication of allowability of these claims.

In view of the above amendments and arguments, applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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